The CRUSHED STONE JOURNAL

In This Issue

How Crushed Stone Should be Graded for Different Purposes and Why

Manufacturers' Division Annual Banquet Held in New York City

Factors Affecting Electric Power Costs in Crushed Stone Plants

October • 1931

Official Publication
NATIONAL CRUSHED STONE ASSOCIATION

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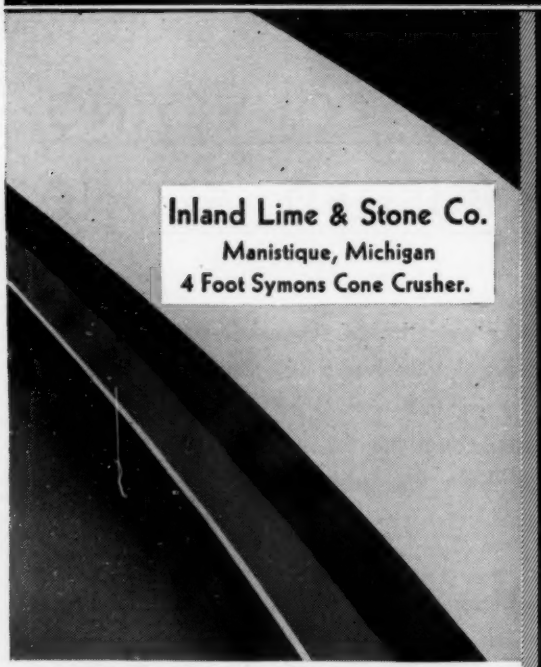

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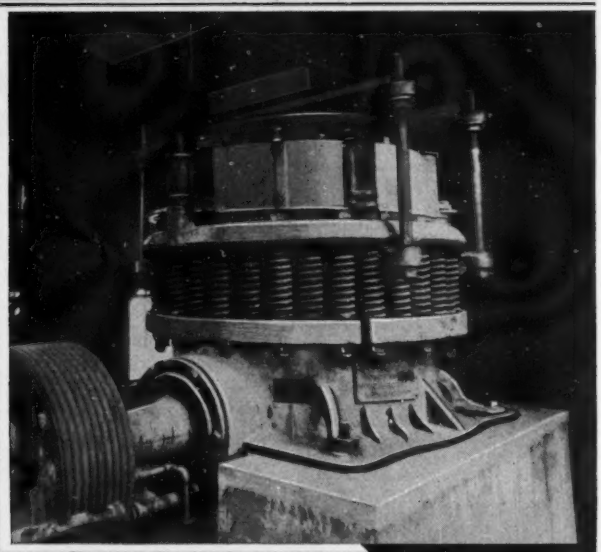

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The Crushed Stone Journal

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J. R. BOYD, Editor

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The first railway car, invented by Gridley Bryant, had wheels 6½ feet in diameter. The load was suspended on a platform under the axles. This platform was loaded, the car was then run over it, and it was raised above the track by a hoist on top of the car. Loads averaged six tons.

How America's FIRST RAILROAD *aided a* PIONEER QUARRY

On October 7, 1826, the first railroad in America, the Granite Railway, was opened at Quincy, Massachusetts. Under the direction of its builder, Gridley Bryant, the first cars (drawn by horses) carried huge blocks of granite from the Bunker Hill Quarry 2¾ miles to tidewater. From there the stone was transported by water to Charlestown for the erection of the Bunker Hill Monument. This small beginning from which our vast railroad systems have grown was considered "visionary and chimerical" at the time. Even Daniel Webster, who witnessed the operation of the first railroad, would not admit that railroads were a success until many years later.

TODAY, the Quincy quarries and the railway are still in operation, but with decided changes in methods and equipment. At first, the stone was broken by dropping large iron balls on heated blocks. In 1803, the quarrymen succeeded in splitting large stones with iron wedges. Later "A" Blasting Powder proved its superiority for getting out dimension stone. Today, Hercules "A" Blasting Powder continues in extensive use in the Quincy quarries.

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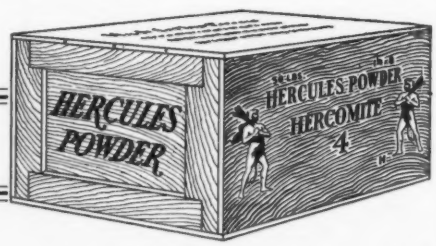

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How Crushed Stone Should Be Graded for Different Purposes and Why

By A. T. GOLDBECK
Director, Bureau of Engineering, National Crushed Stone Association

◆ The standardization of sizes of aggregates is a most important problem to the crushed stone industry. It is certainly not in the interests of economical operation to produce a large number of sizes when a smaller number would serve equally as well. It is extremely desirable that definite steps be taken in the immediate future to standardize sizes of aggregates, and in the following discussion an attempt is made to clarify the atmosphere regarding the sizes of aggregates, so that agreement may be reached on a set of simplified sizes which will be adequate for construction yet economical to produce.

AN INQUIRY conducted within the crushed stone industry by the National Crushed Stone Association in 1929 revealed the fact that well over 80 different sizes and shapes of screen openings were being used to produce crushed stone for various purposes. Some of these sizes showed a negligible difference; yet most construction engineers would readily agree that the quality of the structure or the degree of usefulness of the stone would not be impaired by slight changes in its gradation.

It hardly seems economical to manufacture a large number of sizes when a much smaller number would serve equally as well. From the standpoint of aggregate producers and of consumers it would be desirable to set up a limited number of standard sizes which would be entirely suitable for the main purposes for which crushed stone is used. Such a standard, instead of including 80 some odd sizes, would include, at the most, a dozen, more or less, standard sizes and this comparatively small number would be just as suitable as the larger number now specified for construction.

A simplified size standard must ultimately be formulated in the United States. It is unthinkable that engineers and the industry should be willing to continue under our present lack of system in crushed stone sizes. We are in the same state of chaos and of uneconomic production in the aggregate industries as would exist in the metal industries did we not have standard sizes for sheet metal, pipes, wire, rods, etc.

The following discussion, to parts of which a number of consumers or producers may not agree, is presented for the purpose of attempting to clarify the atmosphere regarding the sizes of aggregates, so that in the near future we may reach an agreement on a set of simplified sizes which will be adequate for construction, yet economical to produce. If consumers or producers disagree with some of the statements made herein, it would be helpful if they would state their disagreement and their reasons therefor. A frank discussion will help in an earlier formulation of a set of standard sizes and this will be beneficial to everyone concerned.

The Measurement of Sizes

In bygone days, sizes of stone were stated in terms of the sizes of openings in plant screens. It was soon discovered, however, that this method of measurement of size was not entirely satisfactory because the method of operating the plant had great influence on the size of the resulting product. Overloading of the screens, wearing of the screen plates, the angle of inclination of the trommel screen, its speed of rotation and many other factors entered as disturbing influences and were the variables which affected the size of the stone finally produced. It became evident that to obtain a correct measurement of size, some standard method would have to be used which could be repeated time and again by different operators. Consequently, the laboratory screen, operated in a standard manner, has become the almost universal apparatus for the measurement of the size of aggregates.

However, even here we have not succeeded in agreeing upon a standard method of measuring size, for engineers have not decided universally on what shape of opening should be used in their laboratory screens.

Some argue strongly in favor of the round opening, on the ground that the diameter is constant in all directions and, consequently, no matter how the stone may be turned as it strikes the opening, it will go through with equal ease. This is not true of the square opening screen because the diameter and the diagonal are not of the same length. But the advocates of the square opening point out that in the measurement of the size of fine materials, square mesh sieves must be used and, consequently, if we are to have a consistent method of measuring size, we must also use square openings for our larger aggregates. They state also that frequently it becomes necessary, and increasingly so in these days of more scientific proportioning of materials, to combine fine and coarse aggregates in a given manner and that if we are to have two different methods for measuring size we must translate the round openings in terms of square openings before we can plot a combined mechanical analysis curve.

The round opening advocates indicate that the majority of the state highway departments, which are large users of aggregates, still specify size in terms of round openings and that this method has come down to us from by-gone times, is well established, and should therefore be continued. They tell us that most specifications are written in terms of round openings and that it would lead to confusion if we were to now write these same specifications in terms of square openings. We would have to change our manner of thought in order to interpret sizes into one standard when we are accustomed to think of them in terms of another.

Before any particular size standard for aggregates can be devised we should agree upon a single method for measuring size. It is possible to state, approximately, the size of square opening which is equivalent to a given size of round opening but it must be evident that there can be no exact equivalent because aggregates vary a great deal in their angularity and this factor has influence on the size of material which will pass through a square opening sieve. The measurement of size is not an extremely accurate procedure in any event, because it is possible that one dimension of some materials may be three or more times as great as in other materials which, according to mechanical analysis, are of exactly the same size.

No matter which method of size measurement is finally agreed upon, it will be feasible to set up a table of approximately equivalent sizes and these equivalents could be continued in specifications until those not used to the new standard might be able to adjust themselves to it.

The writer, although more accustomed to thinking in terms of round openings, is in favor of the square opening method of measuring sizes of aggregates and the present discussion, therefore, will be written with sizes stated in terms of square openings. The following table, however, may be used to interpret these square opening sizes into their approximate round opening equivalents.

TABLE I.—TABLE OF APPROXIMATELY EQUIVALENT ROUND AND SQUARE OPENING TESTING SCREENS*

	Square Openings		*Round Openings*
Size Designation	Opening Inches	Opening Inches	Approximate Equivalents
#4	0.187 x 1.207 =	0.23	¼″
⅜″	0.375	0.45	1/2″
½″	0.500	0.60	5/8″
⅝″	0.625	0.75	¾″
¾″	0.750	0.90	⅞″
⅞″	0.875	1.06	1″
1″	1.000	1.21	1¼″
1⅛″	1.125	1.36	1⅜″
1¼″	1.250	1.51	1½″
1½″	1.500	1.81	1¾″
1¾″	1.750	2.11	2″
2″	2.000	2.41	2⅜″
2¼″	2.250	2.72	2¾″
2½″	2.500	3.02	3″
3″	3.000	3.62	3½″
3½″	3.500	4.22	4¼″
4″	4.000	4.82	4¾″

* Note: An excellent discussion of Testing Screens is given in the May 9, 1931 issue of *Rock Products* by Edmund Shaw, Contributing Editor.

The Uses for Crushed Stone

The uses for crushed stone may be grouped under the following broad, general heads:

1. Concrete Aggregates for use in—
   a. Reinforced Concrete Having Thin Sections
   b. Concrete Highways
   c. Mass Concrete
   d. Cyclopean Masonry
   e. Unit Concrete Construction.
2. Macadam Type Roads
   a. Traffic Bound Roads
   b. Waterbound Macadam
   c. Surface Treated Macadam
   d. Bituminous Macadam
      (1) Bituminous Macadam Using Hot Bituminous Cement
      (2) Emulsified Asphalt Macadam
3. Bituminous Concrete Roads
   a. Coarse Graded, Hot Mix
   b. Fine Graded, Hot Mix
   c. Special Mixes
   d. Binder Course for Sheet Asphalt
   e. Mixed-in-Place Bituminous Concrete
4. Trickling Filters in Sewage Disposal Work
5. Railroad Ballast
6. Agricultural Limestone
7. Fluxing Stone for Blast Furnaces
8. Stone Dust for Various Purposes

No doubt there are a number of other uses for crushed stone but the above mentioned uses probably include those of greatest importance and comprise the bulk of the crushed stone produced.

A Proposed Table of Standard Sizes

Not only is crushed stone used for the above purposes but so also with some exceptions are gravel and blast furnace slag. It would be desirable, as nearly as this is practicable, if all coarse aggregates could be standardized in size and with this idea in view the representatives of the three mineral aggregate industries, including Fred Hubbard and H. J. Love of the National Slag Association, Stanton Walker of the Na-

tional Sand and Gravel Association and the writer representing the National Crushed Stone Association agreed tentatively, and as a first step looking toward size standardization, that the following table of sizes would take care of most of the uses for these materials. All of these representatives recognize the possibility that later discussions from their respective industries and from consumers may show the desirability of changes in their proposed sizes but until more information is brought to light the present sizes are suggested as those most suited for the various construction purposes.

It will be noted that the 12 sizes are composed in part of primary sizes and in part of sizes made up by combination of these primary sizes. There are two sets of primary sizes and their combinations shown in Groups 1 and 2. It is not the intention that any one plant must produce all 12 sizes but rather that it will produce the sizes in either of the groups.

The following discussion will point out the reasons for the gradations required of crushed stone for different purposes and a study of Table II in connection with these various uses will give some indications of the adequacy of the sizes proposed.

1. Concrete Aggregates

The coarse aggregate in concrete serves two principal functions. It acts as a filler and thereby reduces the cost of concrete. Also, it greatly reduces the shrinkage which would otherwise take place in the concrete mass. In concrete construction it usually is advantageous to use as much coarse aggregate as is practicable without sacrificing the necessary workability. The gradation becomes an important factor, for upon it, in large measure, depends the workability of the concrete mass and, therefore, the gradation should be so designed as to promote optimum workability. The maximum size of stone used is oftentimes governed by considerations of economy. It costs money to crush down ledge rock to very small sizes and, therefore, from the production standpoint it

TABLE II.—JOINT TECHNICAL COMMITTEE OF THE MINERAL AGGREGATES ASSOCIATIONS

PROPOSED STANDARD SIZES OF COARSE AGGREGATE INTENDED TO COVER REQUIREMENTS FOR ALL LOCALITIES

No.		Nominal Size Sq.	Circular Equiv.	3½	3″	2½″	2″	1½″	1″	¾″	½″	⅜″	#4	#8	#100
	1	2½″-3½″	3″-4¼″	90–100	35–70	0–15									
	*2	2″-3½″	2½″-4¼″	90–100	50–80	20–50	0–15								
	3	1½″-2½″	1¾″-3″			90–100	35–70	0–15							
F,A	4	1″-2″	1¼″-2½″				90–100	35–70	0–15						
F,A	5	¾″-1½″	⅞″-1¾″					90–100	20–55	0–15					
F	6	½″-1″	⅝″-1¼″						90–100		0–15				
F,A	7	#4-2″	¼″-2½″				95–100		35–70		10–30		0–5		
F,A	8	#4-1½″	¼″-1¾″					95–100		35–70		10–30	0–5		
F,A	9	#4-1″	¼″-1¼″						90–100		25–60		0–10		
F,A	10	#4-¾″	¼″-⅞″							90–100		20–55	0–10		
F,A	11	#4-½″	¼″-⅝″								90–100		0–15	0–5	
F	12	0-#4	0-¼″										85–100		10–30

* Note:—Federal Specification Board Size 2″-3″.
Sizes adopted by Federal Specification Board designated by "F".
Sizes adopted by American Society for Testing Materials designated by "A".

PROPOSED STANDARD SIZES OF COARSE AGGREGATE FOR USE IN ANY ONE SPECIFICATION OR LOCALITY
Group #1

No.		Nominal Size Sq.	Circular Equiv.	3½″	3″	2½″	2″	1½″	1″	¾″	½″	⅜″	#4	#8	#100
	2	2″-3½″	2½″-4¼″	90–100	50–80	20–50	0–15								
F,A	4	1″-2″	1¼″-2½″				90–100	35–70	0–15						
F	6	½″-1″	⅝″-1¼″						90–100		0–15				
F,A	7	#4-2″	¼″-2½″				95–100		35–70		10–30		0–5		
F,A	9	#4-1″	¼″-1¼″						90–100		25–60		0–10		
F,A	11	#4-½″	¼″-⅝″								90–100		0–15	0–5	
F	12	0-#4	0-¼″										85–100		10–30

PROPOSED STANDARD SIZES OF COARSE AGGREGATE FOR USE IN ANY ONE SPECIFICATION OR LOCALITY
Group #2

No.		Nominal Size Sq.	Circular Equiv.	3½″	3″	2½″	2″	1½″	1″	¾″	½″	⅜″	#4	#8	#100
	1	2½″-3½″	3″-4¼″	90–100	35–70	0–15									
	3	1½″-2½″	1¾″-3″			90–100	35–70	0–15							
F,A	5	¾″-1½″	⅞″-1¾″					90–100	20–55	0–15					
F	6	½″-1″	⅝″-1¼″						90–100		0–15				
F,A	8	#4-1½″	¼″-1¾″					95–100		35–70		10–30			
F,A	10	#4-¾″	¼″-⅞″							90–100		20–55	0–10		
F,A	11	#4-½″	¼″-⅝″								90–100		0–15	0–5	
F	12	0-#4	0-¼″										85–100		10–30

generally is economical to use the material in as large a size as practicable for the particular work being constructed.

Furthermore, the cost of the concrete for a given strength, or for a given degree of porosity, or permeability, is controlled to some extent by the maximum size of the coarse aggregate, for, in general, the smaller the maximum size, the greater the cement content necessary in the concrete. It is well known that as the maximum size of the coarse aggregate is decreased, the larger must be the ratio of sand to coarse aggregate to promote workability; consequently, the higher becomes the surface area of aggregate and therefore the higher must be the water-cement ratio for a given quantity of cement.

It follows, therefore, that to preserve the same water-cement ratio and approximately the same strength, more cement must be used with the finer graded aggregates. It is economical, then, to use as large a coarse aggregate as is feasible, taking into account the workability desired and the kind of structure to be produced.

a. Reinforced Concrete, Thin Sections

For thin sections of reinforced concrete, where the reinforcing steel is close together or close to the forms, naturally small sized coarse aggregate must be used. This size may be a maximum of ½ inch, ¾ inch or 1 inch, depending upon the conditions.

b. Concrete Highways

For concrete highways, most of the state highway departments now specify a maximum size of 2½ inches when measured by the round opening screen and this is approximately equivalent to 2 inches in maximum size when measured by the square mesh screen. Considerations of ease of finishing and workability of the concrete govern to a considerable extent the maximum size of crushed stone for highway construction. A 2-inch maximum size has given excellent results, although in some states a still larger size is used with satisfaction.

c. Mass Concrete

For mass construction it will prove to be economical to use a still larger size of coarse aggregate, in some cases extending up to 3½ inches.

d. Cyclopean Masonry

Cyclopean concrete is merely another form of mass concrete in which large size stones or plums are embedded in the concrete mass and, accordingly, for purposes of economy, a large size coarse aggregate should be employed, extending up to 2, 2½ or 3½ inches. However, cyclopean concrete frequently calls for at least 6 inches of concrete between the embedded large size stones or "plums" and, accordingly, to accomplish this purpose, it may be unwise to attempt to use too large a maximum size for the coarse aggregate.

e. Unit Concrete Construction

Unit concrete construction includes such constructions as building block, reinforced concrete pipe, sewer manhole rings, etc. These generally are of thin section and accordingly demand a small maximum size of material such as ½, ¾ or 1 inch, depending on circumstances. In some cases stone screenings of No. 4 or ⅜ inch maximum size are used. In these cases the maximum size is selected to give the requisite workability and surface finish demanded by the particular construction concerned.

Gradation for Concrete Coarse Aggregates

As a rule the minimum size of coarse aggregate extends down to the No. 4 sieve and for most purposes a so-called straight line gradation extending from the No. 4 sieve up to the maximum size is about the best gradation to be used from the standpoint of workability of the concrete, economy and strength. Gradations shown in Table II under Nos. 7, 8, 9, 10 and 11 should be satisfactory for the principal uses of concrete.

Note that a tolerance is placed on all of the different screens in the specification. Such a tolerance is necessary to allow for the variations in production which are bound to occur and to allow also for the difference between laboratory and plant screening methods. It should be pointed out that a too high percentage of fine particles in the coarse aggregate is not desirable, for this leads to a grainy and unworkable mixture. It is undesirable to have too high a percentage of any one size, or a lack of any one size, but the gradation should be uniform from the maximum to the minimum. A smooth gradation curve from the maximum to the minimum size, and preferably in the form of a straight line gradation, has been found to give excellent results.

Crushed Stone Sand as Fine Aggregate

Crushed stone is now being manufactured into stone sand by a number of companies for use as a fine aggregate in concrete. This material is proving to be very satisfactory and gives concrete of high strength and durability, provided the parent rock is of durable character. The following gradation specification for stone sand is suggested as suitable for material of this type.

	Per cent
Passing ⅜"	100
" No. 4	90 to 100
" No. 16	45 to 80
" No. 50	7 to 30
" No. 100	0 to 7

It is to be noted that a maximum of 7 per cent of dust passing the No. 100 sieve is suggested. This is somewhat higher than the amount of 100 mesh material generally permitted in natural sand but the reason for this is that well prepared stone sand con-

sists entirely of particles of stone whereas the fine material in natural sand may consist entirely of clay. The dust in the stone sand aids in the workability of the concrete and is a desirable feature in the gradation. However, the amount of dust may be governed to some extent by the concrete proportions required. The workability of lean concrete in particular will be benefited by the presence of the stone dust.

2. Macadam Type Roads

a. Traffic Bound Roads

Traffic bound crushed stone roads are built by allowing the traffic to compact the broken stone layers in thin courses and the road is maintained by constant dragging during the compacting operation. Obviously stone which is too large in size is objectionable to traffic. It is equally obvious that if the stone contains too high a percentage of dust, such roads will be excessively dusty and objectionable to the travelling public. Consequently, the size of stone suitable for traffic bound construction must be limited in both the maximum and minimum sizes.

In the formative stage of the traffic bound surface it is permissible to use a somewhat larger size stone than should be used after the road has attained sufficient thickness to adequately support the traffic, although even in the base course it is not desirable to use too large a stone. Gradation Nos. 9, 10 and 11 are suggested for this type of construction. The coarser size may be used in the bottom of the road during the initial stages of construction and the finer size after the road has attained the desired thickness.

b. Waterbound Macadam

Specifications for waterbound macadam sizes vary in different sections of the country depending in a large measure upon the quality of the stone. In general, the softer the stone, the larger the size which should be used for the reason that the softer stone crushes under the roller more readily than hard stone. The stability of waterbound macadam depends upon the interlocking of the stone and also upon the cementing value of the screenings used as the filler. If the graded material were used, in waterbound macadam construction the voids in the rolled course would be smaller than when a one size stone is used. This would interfere with the proper infiltration of the stone screenings used to bind the large stone together. Moreover, the segregation of the large and small sizes would produce a non-uniform layer of variable load-supporting capacity. Accordingly, a more or less one-size stone is advocated as the coarse aggregate in waterbound macadam construction. However, a graded stone is sometimes used.

Where trap rock or stones of a similar, hard, tough nature are used, the sizes of stone should be from 1 to 2 inches with a gradation as in size No. 4.

For the softer stones use the 2 to 3½ inch, or even larger size measured by square opening sieves. The 2 to 3½ inch size material should have the No. 2 gradation.

The 2½ to 3½ inch material should be graded as in No. 1. Screenings for the above material should be either the 0 to ½ inch or the 0 to No. 4 with the following gradations.

			Per cent
No. 12	0 to No. 4	Passing ⅜"	100
		Passing No. 4	85 to 100
		Passing No. 100	10 to30
Nos. 11 and 12 combined	0 to ½ in.	Passing ¾"	100
		Passing ½"	90 to 100
		Passing No. 100	5 to 15

The cementing value of screenings is dependent in a very large measure upon the presence of sufficient fine dust. A stone which normally is not supposed to have high cementing value may, when it has sufficient dust, have even higher cementing value than another rock deficient in dust, but normally supposed to have high cementing value. Thus the cementing value of quartzite having plenty of fine dust passing the No. 100 sieve may actually exceed that of limestone which is deficient in dust.

c. Surface Treated Macadam

When macadam is surface treated with bituminous material, this treatment is usually given a cover coat of small size stone. The objects of the stone cover are:

1. To hold the bituminous material in place.
2. To help fill the surface voids in the top surface of the macadam.
3. To provide a wearing mat on the road surface.
4. To serve to further smooth the local inequalities in the road surface.
5. To render the surface non-skid in texture.

The size of the stone is governed by the amount of bituminous material used and by its consistency. Obviously, a binder of high viscosity and which must be heated, must be applied in a comparatively thick layer and, consequently, will require large size cover material to make such a layer stable. The large size stone will not be displaced for it is firmly held by such a binding medium. On the other hand, fluid road oils or tars of low viscosity will not remain on the road in any great film thickness and the cover material required to blot them and hold them in place should be of a comparatively small size.

Cover stone should by all means be clean and not dust-coated for there must be good adhesion between the stone and bituminous cement. The maximum size must be suited to the amount and type of bituminous material applied so that both stone and bitumen will remain in place. Experience has shown what these sizes should be. A non-skid surface should be produced and consequently the stone should not be too fine nor should it contain too many fine particles, for a gritty surface is desired.

To satisfy these requirements it is recommended that the gradations Nos. 10 and 11 be used.

d. Bituminous Macadam

Up to a few years ago bituminous macadam roads, built by the penetration method, were constructed entirely with a hot bituminous cement which made it necessary that the stone meet certain specific requirements with regard to gradation and cleanliness. Recently, however, in this type of road not only have hot bituminous cements been used as the binding medium, but modifications of penetration macadam have made use of bituminous emulsions which are almost as liquid as water and which therefore penetrate with great ease. Also, lately, still another type of bituminous macadam has been devised which makes use of an initial treatment of light oil before the final application of the more viscous bituminous cement.

It becomes necessary therefore to consider the sizes of stone for bituminous macadam with particular reference to the kind of bituminous treatment given.

(1) *Bituminous Macadam Using Hot Bituminous Cement.* With this type of construction, the surface course of which is usually built to a thickness of 2½ to 3 inches, the construction practice calls for the use of large size stone, more or less uniform in size, so that there will be a high percentage of large size voids into which the hot bituminous cement may penetrate easily. After the application of the bituminous cement, the voids are closed with so-called choke stone after which still a second or third penetration of bituminous material may be given with a final cover of smaller size material.

For the sake of the maximum stability it is important that the large size stone be as large as the thickness of the course will permit. When trap rock is used, the sizes of stone employed are generally smaller than where softer varieties of rock are used. For trap rock the coarse stone should be from 1 to 2 or from 1½ to 2½ inches in size, while for the softer stones it is customary to use material from 2 to 3, or 2 to 3½ inches in size. The reason for the larger size stone in the case of the softer material is that the softer material breaks up more easily under the action of the roller and thereby creates fine stone which tends to fill the voids between the coarser material. Too much breaking up of the coarse stone would be detrimental to the proper penetration of the bituminous material and this breakage is prevented to a considerable extent by the use of the large size stone. A thicker top course is also usually employed where soft stone is used. It is quite important that the stone for penetration macadam be reasonably free from dust coating when hot bituminous material is used because otherwise there may be a lack of adhesion between the bituminous cement and the stone. For the coarse stone in bituminous macadam it is therefore recommended that, when trap rock or similar material is employed, the gradation be that given under Nos. 3 and 4.

With soft stone, it is recommended that gradation No. 2 be used.

The stone should be uniformly of the above gradation so that there will be uniformity of voids in the surface before the application of the bituminous material; otherwise, particularly if there is too much fine material, puddles may form in the surface and these will become weak spots because of the lack of penetration of the bituminous material. The keystone or choke stone must be of such a size that when rolled into the bituminous treated coarse aggregate it will be forced into the voids and will produce a thoroughly compacted surface. For the 1 to 2 inch coarse aggregate the choke stone should be the No. 4 to ¾ inch and for the 1½ to 2½ inch aggregate, the choke stone should be ½ to 1 inch.

The No. 4 to ¾ inch material should be graded as in No. 10. When 2 to 3 inch, or 2 to 3½ inch coarse stone is employed, as in the case of soft aggregate, the choke stone should be from ¾ to 1½ inches in size and should have the No. 5 gradation.

Cover material for this large size aggregate bituminous macadam should be the No. 4 to ¾ inch size.

(2) *Emulsified Asphalt Macadam.* Emulsified asphalt macadam differs from hot bituminous cement macadam very largely in that precautions must be taken to prevent the extremely liquid emulsion from flowing away from the stone. It is necessary to fill the voids in the large stone with stone chips before the application of the emulsion and for this purpose ¾ inch round to No. 10 size is specified. This size does not correspond to any size given in Table II but the No. 12 size with the dust removed would probably be suitable.

3. Bituminous Concrete Roads

For our present purpose the term "bituminous concrete" will be made to include:

(a) Coarse graded, hot mix bituminous concrete.
(b) Fine graded, hot mix bituminous concrete.
(c) Special cold mixes such as Amiesite, Tarvia-lithic and mixtures of a similar nature.
(d) Binder course for sheet asphalt.
(e) Mixed-in-Place Bituminous Concrete.

a. Coarse Graded Bituminous Concrete

The function of the coarse aggregate in bituminous concretes, in general, is to make for economy and, in general, the higher the percentage of coarse aggregate which it is possible to place in the mixture, the more economical will that mixture be. The gradation of the coarse aggregate is made such that the most economical mixture will result and at the same time the greatest density will be obtained. At the same time the item of workability and ease with which the mixture may be placed and raked into position is not unimportant. The same gradation which applies to coarse aggregate for Portland cement concrete applies equally well to bituminous concrete. For practical purposes a straight line gradation from the minimum

to the maximum sizes gives an excellent gradation for coarse aggregate for bituminous concrete. It is important that the gradation be such as to give a low percentage of voids, for the higher the percentage of voids in the coarse aggregate, the higher must be the percentage of bituminous mortar in the mixture and, consequently, the greater must be the quantity of bituminous cement used. Thus, a good gradation for the coarse aggregate is an important consideration in the economy of the mix. The No. 4 to 2 inch, or the No. 4 to 1 inch are sizes commonly used for this purpose and gradations Nos. 7 and 9 might well be used. Gradation No. 8 for the No. 4 to 1½ inch size could likewise be used to advantage.

b. Fine Graded, Hot Mix Bituminous Concrete

The same remarks with regard to gradation of coarse graded bituminous concrete apply equally well to fine graded bituminous concrete. Here, however, the stability of the mix depends to a greater extent upon the stability of the mortar portion, or matrix, of the bituminous concrete, for an increased amount of mortar is used so that the interlocking effect of the coarse aggregate may, to some extent, be lost. Fine graded bituminous concrete employs more bituminous cement and, moreover, requires a smaller size of stone. It, therefore, in general is not as economical to use as the coarse graded mixture. The coarse aggregate should have a smooth gradation curve. For practical purposes the gradations Nos. 10 and 11 may be used to advantage.

c. Special Cold Mixes, Such as Amiesite, Tarvia-lithic and Mixtures of a Similar Nature

Generally, but with some exceptions, mixtures which are laid cold depend upon the evaporation of the lighter portions of the bituminous binding material for the hardening of the bituminous cement with the resulting stiffening of the mixture. Consequently, the gradation of the aggregate must be so arranged that an open mixture will result, otherwise evaporation would be retarded and the mixture would remain in an unstable condition for too long a time. Mixtures such as Amiesite and Tarvia-lithic are mixtures of this nature. Generally, Amiesite is laid in two courses, the bottom course being composed of coarse graded aggregate and the top course of finer graded material. In both courses, the idea is to obtain a gradation which will give a rather high percentage of voids and this will result in an open mixture. The bottom course is generally made to a compressed thickness of 1½ inches and the top course to a compressed thickness of ½ inch. For the purpose of obtaining maximum stability it is well to make the maximum size of the coarse aggregate as large as the thickness of the course will permit. To produce these conditions, to the maximum possible extent, namely, openness of mix and high stability, the following gradations of aggregate are advocated by the Amiesite Company for the bottom and top courses respectively.

Bottom Course	Passing 1½ or 2 inch, circular	100 per cent
	Retained on ⅜ inch, circular	100 per cent
Top Course	Passing ⅝ inch, circular	100 per cent
	Retained on No. 8 sieve	100 per cent

The stone for the bottom course does not seem to correspond with any size or combination possible in Table II but the stone for the top course closely corresponds with gradation No. 11, No. 4 to ½ inch.

The Tarvia-lithic mixture is made with three sizes of stone. It is laid cold and consists of a bottom or binder course, usually of coarse or intermediate size mixture and a top course of fine mixture. For a finished depth of 2½ inches to 3 inches, the coarse size stone should be from 1 to 2 inches in size, square mesh. The intermediate mixture for the second course should be from ⅜ to 1 inch and the fine mixture from No. 4 to ½ inch size. Gradations suitable for these respective mixtures may be obtained with No. 4, 1 to 2 inch, No. 6, ½ to 1 inch and No. 11, No. 4 to ½ inch.

Each of these respective gradations is such that the underlying mixture will contain surface voids into which the mixture next above will become interlocked. The use of the finer mixture on the top surface helps to seal the surface against the penetration of water while the open mixture in the bottom layer allows of the volatilization of the lighter oils in the tar and permits of a more rapid setting up of the Tarvia-lithic mixture. The specifications issued by the Amiesite Company, and also by the manufacturers of Tarvia-lithic, call for sizes of stone stated in terms of round opening screens and the sizes given herein are the closest approximation to the round opening sizes possible with a selected series of square mesh openings. Considerations involving the shipment of the material and ease of handling the material from the cars have also led to the selection of the type of gradation stated above for both Amiesite and Tarvia-lithic.

d. Binder Course for Sheet Asphalt

The binder course for sheet asphalt pavement is usually a hot mixture composed of coarse aggregate, sand and a bituminous binder and the idea is to obtain a gradation of the coarse aggregate which will result in a mixture of high stability and high density. Consequently, the stone should be well graded from fine to coarse. The binder course is usually 1½ inches in compacted thickness and consequently the maximum size of the coarse aggregate employed should not be over this figure. The No. 4 gradation, No. 4 to 1 inch, is suggested as one which meets all of the requirements for a sheet asphalt binder.

e. Mixed-in-Place Bituminous Concrete

The mixed-in-place bituminous concrete surface has become highly important within the past few years.

It furnishes a comparatively cheap and yet a very serviceable pavement. It is generally laid with a cold bituminous binder and it depends for its stability upon the evaporation of the lighter oils in that binder. Consequently, the stone must be of an open gradation which will permit of the ready evaporation of the more volatile portions of the bituminous material. Engineers have different ideas as to what is the very best gradation for the mixed-in-place type of construction and much depends upon the manner in which this surface is built. In some cases it approaches a bituminous macadam in its characteristics and when this is so the surfacing is thicker and the stone naturally should be larger than is the case when an attempt is made to build merely a thin mixed-in-place surface. Gradation No. 6, ½ to 1 inch, applies to mixed-in-place stone surfaces as they are most usually constructed and this gradation would be suitable for surfaces 1½ to 2 inches in thickness.

4. Stone for Trickling Filters in Sewage Disposal Works

It has been stated by one of our prominent sanitary engineers that stone suitable for use in trickling filters must have the following characteristics. It must be durable, that is, it must not disintegrate. It must not pack or cement together. It must have surfaces which are rough enough to retain the bacterial jelly and at the same time not too rough to prevent the periodic sloughing off of the stored load.

Although nothing is said in those statements with regard to gradation, it is evident that the facilitation of drainage is a most important consideration and therefore the grading of the stone is of high importance. The following specification probably is typical of specifications for size of stone for use in trickling filters.

Size. The filtering material shall be of such size that as loaded on the car not more than 5 per cent by weight of any carload will pass through a screen having round holes of 1 inch in diameter, (approximately ¾ of an inch square) and not more than 1 per cent by weight of any carload will fail to pass through a screen having round holes of 2½ inch in diameter, (approximately 2 inches square).

Provision may also be made for re-screening the stone in case it does not meet the requirements. The question of cleanliness is also considered important because if the stone is dust-coated, the dust will wash down through the material and collect in layers, thereby interfering with proper drainage. No doubt better drainage could be obtained by making the stone more of one size, but at the same time such stone would have a decreased surface area and, consequently, it is graded in size from the above stated minimum to the above stated maximum sizes. Note, however, that the above gradation may be satisfied by size No. 5, ¾ to 1½ inch, provided extra care is taken to obtain thorough screening on the small size screen.

5. Railroad Ballast

The proper size of railroad ballast does not seem to have been settled with any great degree of certainty. The prime function of railroad ballast is to support the heavy train loads and distribute them properly to the softer subgrade. Still another function is to provide track drainage. Obviously, the rough angular faces of crushed stone are highly beneficial in making for stability. It is possible that a relatively coarse gradation makes for the best stability although our tests do not support this supposition. The presence of excessive fines interferes with proper drainage and, moreover, the fine material is broken up more easily than the coarser material under the action of the tamping tools and traffic. Fine dust is not desirable as this leads to a dusty roadbed and also clogs the ballast and interferes with drainage. Moreover, it cements the ballast together and makes for more difficult track maintenance. The Committee on Ballast of the American Railway Engineering Association has recommended the following gradation.

	Per cent
Passing 2¾″ round opening (equivalent to 2¼″ square)	95
Passing 1¼″ round opening (equivalent to 1″ square)	40 to 75
Passing ¾″ round opening (equivalent to ⅝″ square)	0 to 5

The purpose of the intermediate size screen is to control to a degree the uniformity of the gradation and if the limits are set wide enough there will be no difficulty in production. However, the above size does not seem to fit any size in Table II although a combination of 4 and 5 might produce a suitable gradation. In any one plant, on the other hand, it is not likely that sizes 4 and 5 would both be produced.

6. Agricultural Limestone

In addition to the above uses, stone is used for agricultural purposes when it is sold as agricultural limestone. It is also used for fluxing purposes in blast furnace operation and, of course, stone dust is used for a wide variety of purposes. Agricultural limestone and stone dust are always quite fine in size and in the case of agricultural limestone there seems to be no standard gradation required throughout the country, the finer the material, the more surface area it presents to the dissolving action of the soil acids. On the other hand, the coarser material is dissolved more slowly and serves to continuously feed the soil as it gradually goes into solution. However, the most finely ground limestones are considered most desirable for agricultural limestone purposes and one way of evaluating various ground limestones is on the basis of their relative effective areas, that is to say, on their relative degrees of fineness. This subject is quite involved and was discussed in an admirable manner before the 1928 convention of the National Crushed Stone Association.[1]

[1] "Evaluating Limestone Products" by Firman E. Baer, Director of Soils, Department of the Ohio State University, Columbus, O., 1928 Proceedings of the National Crushed Stone Association).

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Manufacturers' Division Annual Banquet Held in New York City

◆ The New York State Crushed Stone Association and Executive Committee of the National Association held meetings concurrently---Banquet drew exceptional attendance.

IF WE share with Campbell the sentiments expressed in his prophetic words, "Coming events cast their shadows before," those present at the annual banquet of the Manufacturers' Division held at the New Yorker Hotel, New York City, on Friday evening, October 23, cannot help but hold a most optimistic viewpoint as to the success of our forthcoming annual convention in Pittsburgh. Far from reflecting a spirit of pessimism or holding any doubt as to the success of the Pittsburgh Convention or the Manufacturers' Division Exposition which will be held in conjunction therewith, there was a distinct atmosphere of optimism pervading the recent meeting in New York. In the first place, in view of the business condition of the country the record-breaking attendance at the dinner was no less than amazing, there being a total present of between eighty and ninety. Also there was evidenced by the manufacturers' representatives present a keen interest in the forthcoming exposition and there is every indication that the space will be oversubscribed as has been the case for the last few years.

B. G. SHOTTON
Chairman of the Manufacturers' Division

Immediately preceding the serving of the banquet, at the request of B. G. Shotton, Chairman of the Division, the entire assembly arose for a moment in silent tribute to the memory of N. S. Greensfelder, first chairman of the Manufacturers' Division, whose sudden death earlier in the year was such a shock to his many friends and associates throughout the crushed stone industry.

Following the serving of the dinner, Toastmaster Shotton called the meeting to order and in his opening remarks expressed to the Division his real appreciation of their helpful cooperation throughout the year. He stressed the forthcoming exposition of the Manufacturers' Division and urged every member of the Division to participate therein with an interesting and instructive exhibit. In passing it is only proper that a word of praise be recorded in behalf of the toastmaster. His task at best is a difficult and exacting one and made doubly so because of the unavoidable realization that the success of the gathering is largely dependent upon his efforts. We have nothing but praise for the masterful way in which Bruce Shotton handled this task. He is deserving of our heartiest congratulations.

Following the opening remarks of Toastmaster Shotton, President Worthen was introduced and in a short address emphasized the value of a closer and more friendly contact between the manufacturers and the active members. He expressed his appreciation for the helpful cooperation which is always forthcoming from the Manufacturers' Division and said that he considered this to be one of the most valuable assets of the Association. In speaking of the forthcoming convention in Pittsburgh President Worthen was most optimistic and expressed the hope that the Manufacturers' Division Exposition would be the most comprehensive and instructive yet held.

President Worthen read to the meeting a telegram received from E. J. Krause of St. Louis expressing his sincere regret at his inability to be present at the meeting of the Executive Committee and the Manufacturers' Division dinner. Regrets were also received from W. F. Wise who had confidently expected to attend, but because of ill health found it impossible to travel such a great distance.

It should be stated here that in accordance with a custom of many years' standing the Executive Committee of the National Association held its Fall meeting earlier in the day. The Division was particularly

fortunate in having the New York State Crushed Stone Association hold its regular monthly meeting in New York at the same time, and it was a pleasure to the Division to have present at its annual dinner members of the Executive Committee and many representatives from the New York Association.

No meeting of the Manufacturers' Division would be complete without remarks from Former-President Graves. Following President Worthen, Mr. Graves was called upon. He devoted a large portion of his talk to reminiscences, tracing the development of the Manufacturers' Division from the handful of men who started it up to the present day.

Following Mr. Graves, brief remarks were made by John Rice, member of the Board of Directors, A. T. Goldbeck, Director of the Bureau of Engineering of the National Association, and W. L. Sporborg, member of the Board of Directors.

Toastmaster Shotton then expressed his particular pleasure in noting that the presidents of three local associations were present at the dinner and he introduced Bernard McKinney, President of the New England Crushed Stone Association, A. S. Owens, President of the New York State Crushed Stone Association and F. O. Earnshaw, President of the Pennsylvania Stone Producers' Association.

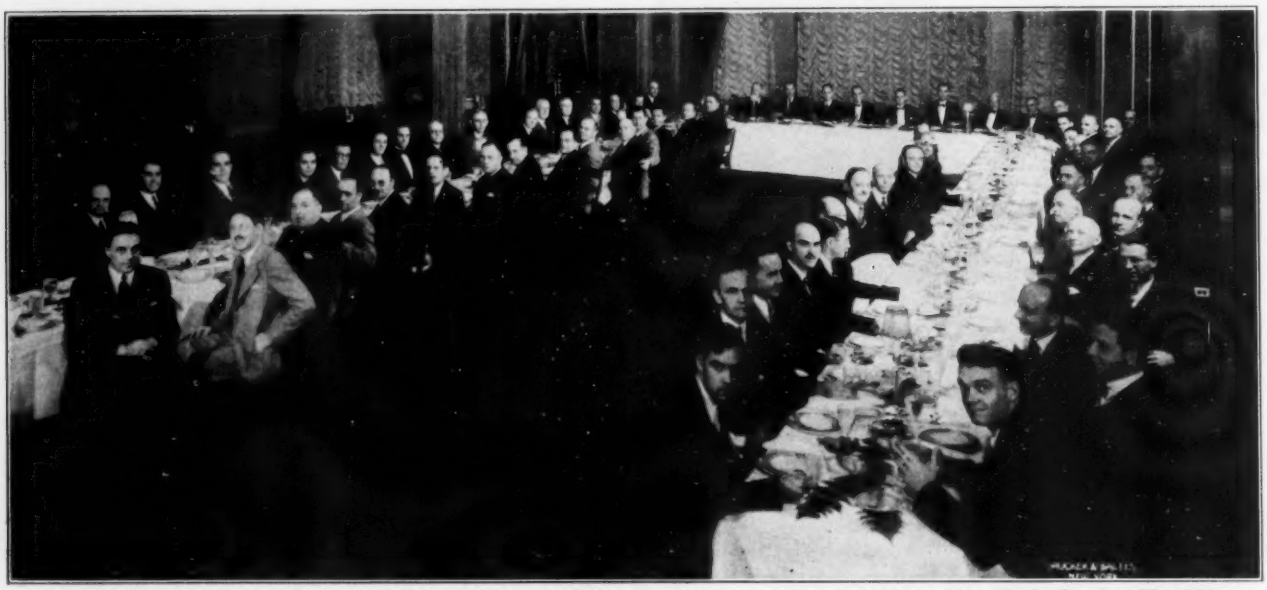
M. B. Garber then made remarks which were also reminiscent in character, calling attention to the fact that many of the previous chairmen of the Manufacturers' Division were present. They were asked to stand in the order in which they held office as follows:

W. E. Farrell, Easton Car and Const. Co., the second chairman.
M. B. Garber, The Thew Shovel Co.
C. B. Andrews, Taylor-Wharton Iron and Steel Co.
H. M. Davison, Harnischfeger Corporation.

It developed that E. G. Lewis who held the office of chairman preceding Mr. Davison, was absent from the meeting only because of a serious injury which he had suffered on Columbus Day, October 12, and from which he is slowly recovering.

The concluding talk of the evening was given by J. R. Boyd, Secretary of the National Association. Mr. Boyd directed his comments to the forthcoming annual convention to be held in Pittsburgh, January 19-22, with specific reference to the Manufacturers' Division Exposition to be held in conjunction therewith. He emphasized the desirability of exhibitors' directing every effort towards making their exhibits of more interest and value and said that the convention program was being formulated with the thought in mind of allowing as much time as possible for an inspection of the exhibits. He pointed out that the Association is conscientiously endeavoring to decrease the expense to exhibitors as evidenced by the decision of the National Crushed Stone Association to open its convention on Tuesday instead of Monday as has been the custom in the past, in order to decrease the time elapsing between the conclusion of the crushed stone convention and the opening of the convention of the National Sand and Gravel Association the following week. He also stressed the fact that due to cooperation with the National Sand and Gravel Association an especial effort has been made with the railroads to permit exhibitors who might also be interested in exhibiting at the Road Show in Detroit the week preceding the dates of the National Crushed Stone Association Convention, to do so and still obtain the benefit of reduced fares to Pittsburgh. Mr. Boyd specifically called attention to the many services rendered exhibitors, all of which are covered by the charge for booth space. He urged

(*Continued on page 24*)



Among those present at the Annual Dinner Meeting of the Manufacturers' Division held in New York, October 23, 1931

Factors Affecting Electric Power Costs In Crushed Stone Plants

By D. LEE CHESNUT
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◆ Reduction of production costs is a goal which is being sought more than ever before by crushed stone producers. Cost of power equipment and its operation is a most important element in the total cost of production and the following discussion of this subject should prove of real interest and value.

EVENTS of the past two years serve as sufficient introduction to this paper. Every industrial operator and owner has been thinking, as never before, in terms of production costs. The age-old law of "the survival of the fittest" dictates that management must move the decimal point of its interest in cost analysis at least one position to the right. American business will not long continue at the current low rate, but those of us who wish to have a place in the procession when it moves, must meantime be on the alert to contribute something to progress in our own industrial activities. Failure to do so is little short of courting disaster.

No accurate statistics indicating that part of total crushed stone production cost which may be chargeable to power equipment and its operation, seem to be available. Several operators have indicated however, that with fixed charges on electrical equipment included, the crushing plant power costs may represent from 12% to 15% of the total production cost for the average plant. The ratio of power cost to total production cost in many industries is far lower than this.

It is our intention to discuss some of the fundamentals affecting the cost of operating electrical equipment. In doing so, we must at times, necessarily refer to the production equipment which is operated by electric motors. It is not our intention to dictate the types of mechanical equipment or processes best suited to your conditions, or to usurp the field of those supplying such equipment. But we can point out to advantage how your choice and use of production equipment may affect your power costs.

We also recognize that in a paper of this type, it is just as impossible for us to recommend any definite program for a specific plant as it would be for a physician to prescribe specific treatment to a group of patients that he had never seen. We can outline fundamentals only, and yours is the option of applying these fundamentals to your own conditions.

The majority of readers of this paper are operating their plants electrically. The very fact that owners of the remaining mechanically-operated plants of today may at least be wisely considering a change to motor drive, should however, make the comments to follow of interest even to the owners or operators of unelectrified plants.

The fact that boilers still have a good rating, or that engines may have years of life does not necessarily make postponement of change the economical plan. A recent analysis of one such plant requiring 600 HP of motors and a total investment of $22,500 to convert from steam to electrical operation, promises a reduction of approximately $7,000 in annual operating expense—a gross return of about 31% on the investment. The additional years of boiler and engine life available, are too expensive to be continued. This is a fair sample taken from many such investigations. Some have not been as attractive as this; others even more so. Almost invariably however the plant that has changed reports additional advantages; other unforeseen economies in operating expense; usually a greater production due to fewer shutdowns and to closer adherence to calculated machine speeds at all times.

The selection of processes, equipment, and motors can be made most intelligently if the fundamental factors affecting the cost of power be clearly understood. Nearly all power rates have at least two parts: a "demand" clause which is necessary to insure to the public utility company that it will receive fixed charges on the investment necessary to serve a customer; and an "energy" clause, covering payment for the actual amount of energy used. Many power rates have a third, or "power factor" clause, that will be explained later. Let us now consider what the quarry operator can do to operate under the most favorable combination of these three elements of power cost.

Maximum Demand

This maximum demand may be likened to a merchant's inventory. If two merchants each do an annual business of $200,000 but because of better planning, scheduling of incoming goods, etc., "A" is able to do his business with an inventory of $30,000, whereas "B" requires a $50,000 inventory—it is evident that "A" has a lower inventory charge per unit sale. Likewise if two quarries each crush similar quantities and varieties of stone requiring 60,000 kilowatt hours of energy per month; and if "A" can do this with a demand of 400 kilowatts, whereas "B" through inefficient use of equipment demands 500 kilowatts, then "A" is getting a greater "turnover" of his demand and will therefore, earn a lower total cost per unit of energy used.

Most power companies actually meter the maximum demand. Now, realizing that this meter divides every

operating day into periods of usually five, fifteen, or thirty minutes (depending upon a particular power company's standards) and then impartially registers the total power consumed for every one of those intervals, the problem of how to keep down the demand becomes a little clearer—though not necessarily easy. Here are some of the fundamentals:

1. Do not permit all motors to be started simultaneously at the sound of the seven o'clock whistle. Authorize one man to start all the main motors, and see that there is some interval between starting of the larger motors at least.

2. Do not wait until stone is to be dumped into the main crusher to start all the motors. Have them running ten or fifteen minutes (longer in cold weather) ahead of the time the plant actually starts to work, so that the excess "warming up" load has dissipated itself before the plant load begins. The additional energy used will cost less than the saving made in demand.

3. Remember that any friction loads, caused by inefficient countershaft drives, add directly on top of the net useful load demand, and are always highest when the load is at its maximum.

Beyond the above, methods of keeping down the demand depend on the selection and use of plant equipment. Analysis of the daily demands, when normal production conditions exist, will frequently show that the peaks come during the first hour of operation in the morning, though usually not immediately after the official starting hour if care has been taken in starting the motors. Figure 1 is an actual daily demand curve of a typical plant, illustrating this very condition. The reason for the early morning peak seems to be that everyone is full of "pep" and everything soon gets into full swing. Gradually, as the day wears on, personal efficiency decreases slightly, and the load drops off. Obviously, the "turnover" of demand would be greater and the cost of operation lower—maintaining the same daily tonnage—if the load could be averaged out by careful planning and supervision of production. One way to avoid peaks of this nature, is to have a motor-operated feeder ahead of the main crusher. This regulates to a certain extent, the flow of stone, and thus prevents overcrowding of the equipment. Some operators object to feeders on main crushers, where quarry loading is done by shovels larger than one yard capacity. In these cases, the use of a small bin to hold probably an hour's capacity, installed beyond the first conveyor or elevator, feeding the remainder of the plant through a motor-operated feeder will generally serve equally as well.

The extent to which the average crushing plant has become accustomed to handling peak loads is shown by the fact that we are frequently called upon to motorize elevators and conveyors that have a capacity of 300 to 400 tons an hour, when the daily nine-hour capacity of the plant is perhaps only 1200 tons. Increased investment, higher demand, and greater energy consumption are always the result of such installations. The quarry operator must either accept these inefficiencies or else study his plant and plan his production equipment to secure a less spasmodic rate of production.

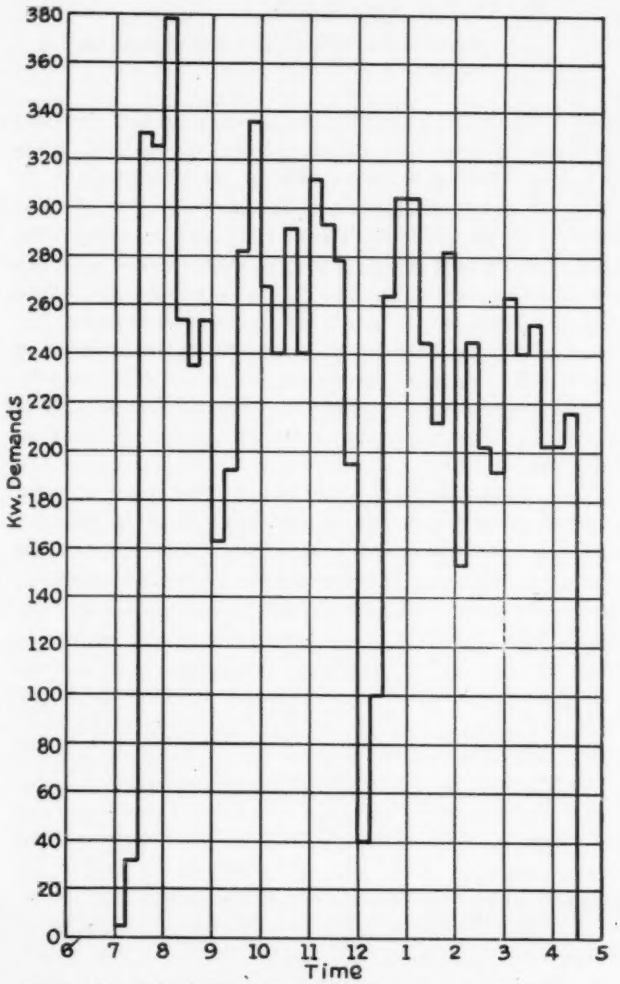

Figure 1. Actual Daily Demand Curve of a Typical Plant

In some industries, we have been able to use successfully, demand control devices to limit the demand to a predetermined point. This is not so generally applicable in the crushed stone industry, because it is very difficult to arbitrarily remove any load at a particular time. If there is a motor-operated air compressor of fair size with respect to the plant demand, and if it is equipped with a receiver large enough to carry the plant for a few minutes with the compressor unloaded, then a demand control device, causing the compressor to unload at otherwise peak demand periods, could be used to advantage. It is possible too, that in the future we may see these demand-limiting devices controlling adjustable speed motors operating feeders. The flow of stone could then be automatically

regulated to give maximum production without exceeding a predetermined maximum power demand. The use of such a device would require a carefully planned plant with a small reserve supply of stone, but should result in minimum investment and minimum power cost for a given production.

All this discussion of demand should be modified by this statement. On some rate schedules, the net cost for the last block of demand kilowatts is so low that the investment for special control could not be justified. Thus the advantage of giving the superintendent a free rein to produce stone far outweighs, in such cases, the small additional demand cost. This is not true on some rate schedules however. Lest someone now take this statement as a basis of asking for uniform power rates, it should be pointed out that differences in methods of establishing demand are fundamentally sound. It is not the power company's fault, for example, that human nature and economic conditions lead men to congregate in great masses in one locality and to avoid this congestion elsewhere. The total consumption of electrical energy for a large part of one state may thus be only just about equal to that of an adjoining metropolitan center. Yet we must admit that the company serving the former territory would require a much higher investment to serve the much greater area, and therefore should have a higher demand charge. There are other equally sound economic factors, justifying differences in rate schedules.

Energy Consumption

The second part of the power bill—payment for kilowatt hours of actual energy used—generally receives less attention from the average quarry owner or operator. He reasons that this is a direct charge for the power he has used and while he wishes it were lower, there is very little he can do about it.

First among those items favorably affecting the amount of energy used, is one that every operator knows for himself better than we—the efficient handling of stone through its various stages. It costs money for every foot that every pound of stone is moved, and the amount of that cost ascends proportionately as the route of the stone is up-grade. The most we can do is to bring you to visualize a stream of pennies on the way to your profit and loss account, every time you see stone traveling here and there over conveyors, elevators, and screens. If the majority of those pennies are to find a secure resting place in the profit account, you should make every foot of every conveyor and elevator pass the acid test and justify its existence. The position of every screen and every crusher ties in closely with this study. Electrical manufacturers and the power companies can supply all the equipment and all the power required to operate any plant under any set of conditions, but you must take the initiative in this part of any program for more economical operation.

Every piece of crushing plant machinery is a link in the production chain. If any piece shuts down, everything preceding it must stop, and the operation of following equipment is usually unproductive. For years, this led operators to believe that the single motor group drive was the sensible means of electrifying such plants.

We must not forget however, that in almost no other industry are conditions for maintaining continuous operation, and efficiencies of line shaft, bearings, belting, so difficult as in a crushing plant. Conditions for such equipment in a machine shop or a textile mill are comparatively ideal as against those in a crushing plant. Yet the modern successful plants in these other industries are almost invariably doing their work with motors applied to each production machine. There are likewise many crushing plants so equipped, and we believe that every one of them would agree that this part of their plan for economical operation has been entirely justified by results.

We have seen some analyses by experts in the field of transmission equipment calculating all belt, bearing and lineshaft losses for specific crushing plants as closely as the many variables would permit. Competent dollar-minded owners faced with these facts, and fully realizing the greater cost of directly-applied motors, have consistently decided in favor of the better job.

We are frequently asked for example, whether a 50 HP motor operating at 25 HP consumes appreciably more power than a 25 HP motor operating at full load. Generally speaking, with well-designed motors the answer is "No." Motors operating below 50% load are invariably good subjects for the kilowatt-hour detective's investigation. There is very little opportunity however, to save in kilowatt-hour consumption by changing to smaller motors, provided the motors are operating at 50% load or above. But please bear in mind that at this point, we are discussing only energy consumption. Comments regarding the objection to lightly loaded motors will be made under the subject of power factor immediately following.

Power Factor

To most users of electrical power who are not actually engineers, this term "power factor" is one of the mysteries of electricity. Yet it is a "something" in which they need to be interested, and about which they need to know more, as in many cases it directly affects operating and investment cost. It is difficult to visualize how or why to avoid any particular set of conditions, unless those conditions are themselves known. It will perhaps be helpful, therefore, to consider a simple, non-technical illustration of power factor.

In Figure 2, "W" is simply a weight lying on top of a smooth table. Suppose that you want to move the weight on the table in the direction of the arrow. You attach a spring scale "A" to a cord and pull straight

forward, parallel with the table top. The spring registers a given number of pounds pull required to keep the weight "W" in motion, and since that pull is all in the direction of the line of motion, it is all effective in doing work, namely, moving the weight.

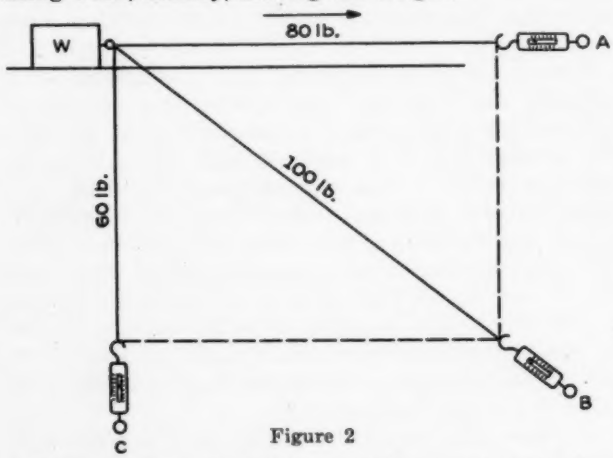

Figure 2

Now suppose the table is slotted, and instead of pulling straight out as in "A," you pull at a downward angle as at "B." It is evident that the scale will register more pounds required to move the weight, because part of the force exerted is doing no useful work. In fact the pull "B" is exactly equivalent to a combination of the original pull "A," plus the straight downward pull "C"—the lengths of each line being proportional to the amount of each pull. It is perfectly evident that pull "C" is absolutely worthless as far as assistance in moving the weight is concerned. Furthermore, going back to "B" and realizing that it is exactly equivalent to "A" plus "C," it is again evident that if scale "A" is used to its full capacity, scale "B" would actually have to be of larger capacity.

Now if this illustration thus far is clear, you are ready to understand all the essential elements of power factor. Instead of weight "W" we have the load of a belt conveyor for example. Instead of the hand pulling the weight we have a motor operating the conveyor. Instead of the spring scale indicating the pounds pull, we have an ammeter in the motor line indicating the actual amperes required to operate the load. Now, an induction motor, either squirrel cage or slip ring, is so constituted that it simply will not and cannot make all its amperes flow "in the direction of the work to be done"—"A." Instead, it insists on always providing some amperes pulling directly downward as at "C," doing no useful work. As in our mechanical illustration, the combination of "A" and "C" is equal to "B," and if an ammeter is put in the motor line, it will actually give only one reading—that equivalent to line "B."

This line therefore, represents the amount of amperes (not power) which must be supplied to operate the motor. However, only that part of these amperes, equivalent to line "A" is useful in turning either the motor driving the conveyor, or the power company's meter registering the amount of work done. Therefore, the ratio of "A" divided by "B," actually called "power factor," is simply a factor used to indicate that portion of an *ampere* load which is actually useful power.

One more peculiar characteristic of the induction motor is that the "useless" amperes "C," remain practically constant at all times for a given motor, whereas the useful amperes "A" vary almost directly with the load. It is evident then, since power factor is the ratio of "A" to "B," that when a given motor is operating lightly loaded, its power factor must be much lower, which means that proportionately more amperes must be provided to do a given piece of work.

The power company must furnish generators, lines and transformers of a size to carry the total amperes "B," but the usual energy meters register only that proportional to line "A." They are therefore entitled to receive fixed charges on the investment required to provide this excess capacity, and this is the basis of the power factor clause which now appears in many rates, and will very likely become much more nearly universal in the near future.

Now therefore, it is evident that to keep the plant power factor as high as possible, it is necessary to have as few "useless" amperes "C" as possible, and following are the ways of accomplishing this:

1. Select motors of a size such that the average operating load, with respect to the motor ratings, will be as high as possible.

2. When applying induction motors use the highest standard speed motor (1800 RPM or below) that can be properly applied to the drive, as the higher speed motors are smaller in frame size and therefore require less of the "useless" current.

3. If pumps, air compressors, or electric shovels with Ward-Leonard control are used, requiring motors 50 HP and above (sometimes even smaller), use synchronous motors on these drives. Synchronous motors can be designed to have no "useless" current "C," and in addition to supply current directly opposite to "C" in direction, and therefore to neutralize some of the effect of the induction motor load.

The first of these points is very difficult of attainment in crushing plant service. Crushers are used to crush a variety of stone sizes, and must be motorized to carry the loads when the finest sizes are being produced. At other times, the motors are necessarily underloaded. Crushing operation also imposes extremely high peak loads, sometimes of appreciable time duration, and every operator prefers a motor large enough to pull through these normal peaks without stalling. Belt conveyors and particularly bucket elevators may have heavy friction loads at start, particularly if they have stopped for any reason while loaded, and the operating motor should have capacity to break them away. Vibrating screens generally re-

quire a larger motor than would be necessary for operating conditions because of the heavy off-center load to be rapidly accelerated to a high speed. All these drives, and particularly the latter, are much harder to start in cold weather. Thus, if a plant is properly equipped to take care of the extreme conditions which must be considered as normal in this class of work, the average operating load, and therefore the power factor, is certain to be low.

Sometimes, however, a study of conditions will lead to some ways of improvement. For example there recently came to our attention, a particular 30″ belt conveyor, operated by a 25 HP motor. A 15 HP motor could readily carry the normal and peak loads of this conveyor. However, whenever a truck load containing a large percentage of fine material is dumped into the crusher, the fine material goes right through, clogs the belt and stalls even the 25 HP motor. This is the type of condition which could probably well be remedied, resulting in improved power factor conditions.

When synchronous motors are considered for pumps, air compressors, or for the drive of a motor generator set on electric shovels, it is usually wise to consider the use of "leading power factor" synchronous motors.

We are frequently asked whether synchronous motors cannot be applied to crushers and thus get the benefit of power factor correction on these larger motors that necessarily operate well under their normal horsepower ratings. This is a logical question, and one which is receiving more and more consideration. Strictly from a power factor standpoint, the application is extremely desirable. Some characteristics of synchronous motors however require very careful study of conditions before such applications are made.

A synchronous motor always operates at a certain definite speed, from which it cannot vary. Hence whenever a crusher gets a sudden peak load, the synchronous motor has no pity on it, but forces it to crush away at full speed. There is no cushioning effect. This puts heavy mechanical strains on the crusher and on the transmission between motor and crusher. Furthermore, the power lines feeding this motor must of necessity reflect these higher peak demands. An induction motor on the other hand, has a characteristic permitting it to "ease off" slightly in speed during peak loads. Thus a crusher will get over a given peak with considerably reduced mechanical strain on itself and on the transmission, and with a lower electrical peak on the power lines.

If the power company has sufficient line and substation capacity that the greater peaks caused by the use of synchronous motors will not cause serious voltage disturbance, and if there is no objection to the increased mechanical strain on crushers and their drives, then we are ready to recommend the use of synchronous motors for gyratory and similar types of crushers. The motors themselves will be entirely successful and they are capable of handling the load of such crushers. As a matter of fact, with further modifications of synchronous motor designs that seem likely of achievement, and with the strengthening of power distribution systems, it is possible that the application of synchronous motors may be extended to jaw crushers within the next few years.

In any event, representatives of the power company should be fully advised of all contemplated applications of synchronous motors to crushers. They should be given full information on the motor characteristics and load conditions, and their approval should be secured before a particular application is made.

There is another way in which any necessary power factor correction can be secured, namely, by the use of capacitors, sometimes referred to as condensers. The capacitor is an extremely reliable device with no moving parts, and consists essentially of two strips of aluminum foil insulated from each other, immersed in oil and hermetically sealed in a can. Thus it requires no maintenance supervision. Electrically—going back to the illustration in Figure 2—the capacitor, in effect, applies a pull to the weight, vertically upwards. The amount of this effect depends upon the size of "KVA rating" of the capacitor, and can be proportioned to secure any desired power factor. Power factor correction secured in this manner however is more expensive than for the equivalent amount secured with a synchronous motor. Thus capacitors are normally used only after synchronous motors have been applied wherever possible, but where still further correction is necessary.

This entire discussion has been predicated on the assumption that electrical power is being purchased from a public utility company. If the power company supplies high voltage power, the user owning the transformers for stepping down the voltage, then in addition to the lower rate earned by keeping the demand down and the power factor up, the size of transformers, main cables and main line switches can also be smaller, resulting in lower investment cost. Likewise these points are of equal importance to the relatively few companies situated where they must generate their own power. Lower demand and higher power factor result in lower generating plant investment.

Careful scrutiny of these three conditions, maximum demand, energy consumption, and power factor, should have a prominent place in any study of production costs. Close cooperation, and an interchange of problems and suggestions, between quarry operators, electrical manufacturers, and power companies, should be developed and extended. Realizing that understanding must precede progress and to the end that there exist a better understanding of these problems in which we are all involved, it is hoped that the foregoing discussion of fundamental factors affecting power costs of crushing plants will be helpful.

A Timely Suggestion for Salesmen[1]

◆ **The following statement was recently issued to the dealers and salesmen in his organization by the president of a prominent paving brick company. It is well worthy of careful consideration, for application to all industry of the principles expressed would certainly be helpful in returning business to normal concitions.**

FOR a number of years the writer has been in close contact with rather a large number of salesmen, both our own and our dealers' and those of other companies. My observations formed by these contacts today are addressed to you as one of our dealers because we have always felt that you and your organization are an integral part of our own sales force.

Never in my experience have the unsatisfactory conditions that exist today been taken in so matter of fact manner by salesmen. Their attitude would indicate that in seeking orders they expect to be turned down; their whole manner would indicate that they are licked and most of them are covering their territory in a prefunctory and half-hearted way.

This condition furnishes food for thought, and I am wondering whether this attitude on the part of the majority of salesmen throughout the United States may not be partly responsible for the delay in the return of prosperity. I have been wondering what the result would be if all the salesmen in this country would immediately change their attitude and go out with determination to pry loose every available dollar's worth of business. Suppose that they would suddenly quit taking "no" for an answer so easily, and proceed with a bull-dog determination to get orders, and then more orders.

Is it not logical to suppose that such a united and cohesive movement among hundreds of thousands of salesmen in this country would increase the business of the nation 15 or 20 per cent as if by magic? If it is, is it not reasonable to suppose that it would increase our businesses in like proportion? This would be enough to start the country back toward normal business conditions, and we would then be part way on the road to prosperity. Normal business is about halfway between the peak of prosperity and the depth of depression; and I believe that an increase of 15 or 20 percent in the nation's business would bring the country back nearly to normal.

It is obvious that the depression from which the country is now beginning slowly to emerge, was the result of economic causes such as over-production, overexpansion and over-buying. I believe that these economic causes have very largely spent their force and that business confidence is the one thing that is most seriously needed to start us on the road to recovery. In other words, I believe that psychology has more to do at the present time with holding back the business of the country than anything else—such things as doubt, fear and pessimism. The American people are victims of their own psychology. When prosperity is booming, most of them think that the sky is the limit. Then when depression comes, they go to the other extreme and think that there is no bottom.

Every man who went through the trying period of 1921 knows that people generally were thinking and acting then exactly as they are now. Following that depression we had the greatest era of prosperity that this or any other nation ever knew. Is it not then reasonable to suppose that, if a man is a pessimist now, he will have reasons to regret it a year from now. Prosperity is a time for caution; depression a time for courage.

It is a well known fact that in periods of depression great reserve buying power is built up, because nearly everyone puts off buying as long as he can, not only the things he wants, but some of the things that he really needs. Not less than 80% of the people have employment even now. The majority of those still employed have not been seriously affected in their incomes, while at the same time the cost of living has gone down to a decided degree; but fear, doubt and pessimism make them abnormally conservative.

How many people do you know who can well afford a new car and who say, "No, I am not going to buy a new car this year as times are too hard"; or, "I am making my old clothes do and not ordering any new ones." Unquestionably, there are millions of people doing exactly this same thing with reference to all kinds of things they need. They have the means to buy and there are things they really want. Just as soon as they get a little confidence, these millions upon millions of people will start to buy, and then the worst phases of the depression will fade away like the morning mist before the rising sun. I believe it is true that 9 out of 10 people with incomes are buying less than they really want and can afford during this period, and when this dammed-up buying power lets loose, we will automatically experience the rising tide of business that will be irresistible.

This situation presents a marvelous opportunity to the army of salesmen and dealers in America to break the back of this depression and lift their country to a position approaching normal. No greater service could be rendered right now than by a united and determined drive on the part of all salesmen and dealers to pry business loose, anywhere and everywhere. It is money in circulation that makes prosperity. Every order that is secured by an aggressive salesman puts that much money into circulation, gives that much more employment, creates that much more buying power. Every time you make a man buy what he really wants,

(*Continued on page 23*)

[1] Reprinted from the National Paving Brick Manufacturers' Association *Business Review*, August 5, 1931.

« « EDITORIAL » »

The Annual Exposition

ONE of the most popular, interesting and instructive features of the annual conventions of the National Crushed Stone Association is the exposition of quarry equipment and machinery held by the Manufacturers' Division of the Association. The purpose of this exposition is two-fold. First, it affords the only opportunity available throughout the year for plant executives and operating men to learn in the brief space of a few hours the latest developments and improvements in the machinery and equipment field. It also enables them, through contact with the technical representatives of the various manufacturing firms represented at the exposition, to obtain first-hand information of the utmost value which could otherwise only be gotten from personal contact or a necessarily extended correspondence. Secondly, the exposition is an actual money saver from the point of view of the exhibitor because it makes it possible for him with a minimum of expense and in a comparatively short space of time to contact the leading crushed stone executives and plant men of the United States and Canada.

There are two elements which contribute largely to the success of the Manufacturers' Division Exposition: First, that a large and representative attendance be present, and second, that the members of the Manufacturers' Division not only participate in the exposition to the fullest extent, but that they make a particular effort to have at the convention exhibits of unusual interest and value. Also it has been found decidedly advantageous to manufacturing companies to have present their technical representatives for discussion and conference with operating men.

The Manufacturers' Division Exposition has increased in size and scope each year since its inception and when it is considered that business in general today is exercising every means for effecting greater economies, it is certain that manufacturers will be quick to take advantage of the opportunity offered by the exposition to contact with such a large percentage of the leading producers of the industry because of the real saving in time and money which is thus made possible.

In planning this year's convention program an especial effort is being made to allow ample time for each and every delegate present at Pittsburgh to give the Manufacturers' Division Exposition a complete and thoughtful inspection. The physical facilities for housing the exposition at the William Penn Hotel are particularly good, as it will be possible to house the entire exposition in one room which is excellently equipped for exhibit purposes.

The exposition folder in which there will be given full details and a plan of the exhibit space is now in course of preparation and will soon be mailed to each associate member company of the Association. It is confidently expected that the exposition to be held in conjunction with our Fifteenth Annual Convention at Pittsburgh, January 19-22, 1932, will be one of the most complete and comprehensive yet held, and we know that the active member companies, realizing the necessity of increasing the efficiency of their operations will take advantage of the opportunity presented by the exposition to acquaint their operating men with the latest developments and improvements and will send them to the Pittsburgh Convention in full force.

A Deserved Tribute

THOSE members of the crushed stone industry who have been privileged to hear Otho M. Graves act in the capacity of toastmaster on the occasion of our annual banquets in the past have been quick to appreciate his exceptional fitness for discharging the exacting duties of that office. We have not realized, however, that others outside of the environs of the crushed stone industry had been equally quick to recognize his outstanding capabilities as a toastmaster. The high spot of the program of the National Safety Congress recently concluded in Chicago was its Annual Banquet held on Wednesday evening, October 14. The annual banquet of the National Safety Congress is an event of outstanding importance, there being numbered among the twelve to fifteen hundred persons who attend many of the foremost leaders of industrial America. It should be distinctly gratifying to our industry to learn that Mr. Graves was selected as the toastmaster for this occasion. It is unnecessary to add that he discharged the duties of this important post in a manner which was both entertaining and inspirational to those present and we can well take pride in the fact that one so intimately identified with the crushed stone industry was accorded such a signal honor.

W. R. Sanborn Appointed to Executive Committee

IT SHOULD be distinctly gratifying to the crushed stone industry to learn of the appointment to the Executive Committee of the National Crushed Stone Association of W. R. Sanborn, Vice-President and General Manager of the Lehigh Stone Company, Kan-

kakee, Illinois. President Worthen is to be commended for his choice of Mr. Sanborn to fill this important post as it would have been difficult to find one more ably fitted to assume the responsibilities of membership on the Executive Committee. Mr. Sanborn has been long and intimately connected with National Association affairs and has served as a member of the Board of Directors for many years, being at present Regional Vice-President of the Northern Region and Chairman of the Association's Transportation Committee. He is an enthusiastic and ardent supporter of the Association and his counsel and advice should be most helpful to the Executive Committee.

Mr. Sanborn was appointed to fill the vacancy recently created by the resignation of Mr. Howard Bair which was accepted with very real regret.

Bulletin No. 7 Meets With Approval

ENGINEERING Bulletin No. 7 entitled, "Investigations in the Proportioning of Concrete for Highways," by A. T. Goldbeck, Director of the Bureau of Engineering, which was recently distributed, has been received enthusiastically throughout the highway engineering profession. Requests to the Washington Office from highway engineers, state and county highway officials and from the engineering staffs of technical universities have been numerous. The file of correspondence in praise of the information contained in this bulletin is rapidly growing. This leads to the observation that the widest possible distribution of this bulletin should be made throughout the highway engineering field and as we have previously stated, the most practical method for accomplishing such distribution is through the assistance of the active members of the Association. Each active member company has been sent a copy of this bulletin which was accompanied by suggested plans of distribution. Orders from member companies to date run well into the hundreds, but it is nevertheless obvious that many have failed to take advantage of this means of bringing to the attention of the users of crushed stone information which would be of distinct interest and value to them. We therefore wish to urge that those companies which have not already done so immediately advise the Washington Office as to the number of copies of Bulletin No. 7 which they will require to insure that adequate distribution is made within their territory.

Highway Research Board Will Meet in Washington

THE Eleventh Annual Meeting of the Highway Research Board, National Research Council, will be held on December 10 and 11, 1931, at Washington, D. C. The meetings will be in the auditorium of the National Academy of Sciences Building, 2101 Constitution Avenue. The sessions will be devoted to discussions of reports of research activities in relation to highway finance, transportation, design, materials and construction, maintenance and traffic.

There is a distinct mutuality of interest between the Highway Research Board and crushed stone producers because of the extensive use of our material in the highway construction field. Crushed stone producers would therefore find it not only interesting but decidedly profitable to attend the forthcoming meeting of the Highway Research Board and it is hoped that a substantial representation from the industry will be present.

Federal Aid Funds Apportioned

OF the $125,000,000 annual appropriation for Federal aid road work which the Secretary of Agriculture, Arthur M. Hyde, divided among the several States on October 15, Texas receives the largest sum, $6,770,221, while Delaware, New Hampshire, Rhode Island, Vermont and Hawaii, each alloted $529,375, receive the smallest sums, according to statistics made available October 15 by the Department of Agriculture.

The new funds are available to the States for immediate obligation on projected construction. The apportionment has been made 2½ months in advance of the usual date so that the States may get an early start on plans for next season's construction.

The Bureau of Public Roads, through which Federal-aid funds are administered, has indicated a desire to accept policies designed to increase employment and to protect labor. Among the acceptable policies are the fixing of a fair minimum scale for unskilled labor and restrictions giving preference to local unskilled labor and to citizens of the State in which work is being done.

If legal, the use of Federal aid will be allowed where labor is employed direct and where such projects can be carried on economically to provide local employment. Restrictions as to hours per day and days per week in order that workers may be continuously employed are also acceptable. The Bureau of Public Roads will not accept the disbarment of a contractor from the award of a contract because he is a nonresident of the State, provided he is the lowest responsible bidder, nor will it accept the limitation of materials to those produced within the State.

Last season Federal-aid road work was greatly accelerated because the regular authorization of $125,000,000 was supplemented by an emergency authorization of a loan of $80,000,000. At the peak of the season more than 155,000 men were engaged on Federal-aid work.

How Crushed Stone Should Be Graded for Different Purposes and Why

(*Continued from page 12*)

7. Fluxing Stone

This material is supplied in large sizes generally from 2½ to 6 inches in size when measured by round openings. This is a special size and perhaps need not be considered in connection with a table of standard sizes.

8. Stone Dust

Stone dust is used for a great many different purposes requiring different degrees of fineness. This subject is too involved to be considered in the present writing and has been treated in special articles by several different writers. An excellent paper has been written by W. M. Weigel, Mineral Technologist, Missouri Pacific R. R. Co., formerly with the U. S. Bureau of Mines. This article is entitled, "Stone Dust, Its Use and Preparation" and appears in the 1927 Proceedings of the National Crushed Stone Association.

TABLE III.—APPLICABILITY OF SUGGESTED STANDARD SIZES

Number	Nominal Size Square Opening (inches)	Circular Equivalent (inches)	Uses of Different Sizes
1	2½–3½	3–4¼	Waterbound Macadam (soft stone)
2	2–3½	2½–4¼	Waterbound Macadam (soft stone) Bituminous Macadam (soft stone)
3	1½–2½	1¾–3	Bituminous Macadam (hard stone) Railroad Ballast (soft stone) combined with 5
4	1–2	1¼–2½	Waterbound Macadam (hard stone) Bituminous Macadam hard stone) Special Cold Mixes Railroad Ballast, combined with 5
5	¾–1½	⅞–1¾	Choke stone for 2″–3½″ Stone, Bituminous Macadam Trickling Filters Railroad Ballast Combined with 4 or 3
6	½–1	⅝–1¼	Choke stone for 1½″–2½″ Stone, Bituminous Macadam Special Cold Bituminous Mix Mixed in Place Bituminous Surface Railroad Ballast, combined with 4 (hard stone)
7	No. 4–2	¼–2½	Concrete Highways Mass Concrete Bituminous Concrete
8	No. 4–1½	¼–1¾	Concrete Aggregate Bituminous Concrete
9	No. 4–1	¼–1¼	Reinforced Concrete Unit Concrete Traffic Bound Roads Bituminous Concrete Sheet Asphalt Binder
10	No. 4–¾	¼–⅞	Reinforced Concrete Unit Concrete Traffic Bound Roads Coarse Screenings for Surface Treatment Choke stone for 1″–2″ Stone, Bituminous Macadam Bituminous Concrete, Fine Graded
11	No. 4–½	¼–⅝	Reinforced Concrete Unit Concrete Traffic Bound Roads Fine Screenings for Surface Treatment Bituminous Concrete, Fine Graded Special Cold Bituminous Mix
12	0–No. 4	0–¼	Fine Aggregate Screenings for Waterbound Macadam

Applicability of the Suggested Standard Sizes

Having considered briefly the desired size characteristics of crushed stone for different purposes, it will be well to study the suitability of these suggested size standards. This may best be done by referring to Table III showing the uses for the various sizes.

A study of this table indicates that most of the uses for crushed stone are cared for by the sizes suggested. Flux stone does not appear but this is not universally produced and in this sense is to be considered as a special product. It is of large size and those plants which produce flux stone may also readily produce the above sizes of commercial stone. Unquestionably, there are other uses for which the above sizes are not entirely suitable or at least are not so considered. It is believed that the tonnage represented by these exceptions is small and to take care of such uses, special sizes, not included in any feasible set of standards, will have to be produced by certain plants.

It is hoped that consumers will study the proposed standard to see how it fits their needs and that producers also will study it so that they may make suggestions regarding its improvement from a producing standpoint. In all probability, producers and consumers will be brought together by the Division of Simplified Practice of the U. S. Department of Commerce to discuss the formulation of a set of standard sizes which will be mutually satisfactory and it is believed that the foregoing sizes as proposed by the technical representatives of the three national mineral aggregates associations will serve as a basis for discussions preliminary to such a conference.

This fact is outstanding—the sizes of mineral aggregates should be standardized.

A Timely Suggestion

(*Continued from page 20*)

or what he ought to have in a period like this, you are doing a distinct service to your country.

Let us, then, start a determined battle for common good. This is an appeal for service and a call for courageous effort. We should not expect prosperity to come quickly—we must get back to normal business first—but we can certainly start a healthy business if we use our best efforts and go out determined to get orders, and refuse to take no for an answer. Let us show what we, who are part of one of the country's fundamental industries, as allies can do. This is an appeal for your co-operation.

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Manufacturers' Division Annual Banquet Held in New York City

(*Continued from page 14*)

all members of the Division to participate in the Pittsburgh Exposition as at no other time throughout the year do they have such an excellent opportunity of contacting so large and so representative a group of crushed stone producers of the United States and Canada. In conclusion he stated that the exposition folder giving full details and also complete booth layout was in course of preparation and would shortly be mailed.

The Division was again fortunate in having Mr. Gordon Buchanan of the C. G. Buchanan Co., Inc., undertake the responsibility for all of the mechanical arrangements incident to the dinner and in concluding the dinner the Division extended to Mr. Buchanan a rising vote of thanks for his efforts on their behalf.

Following is a list of those who were in attendance:

Manufacturers

F. L. Ahlgren, Atlas Powder Co., Wilmington, Del.
C. B. Andrews, Taylor-Wharton Iron and Steel Co., High Bridge, N. J.
J. Barab, Hercules Powder Co., Wilmington, Del.
L. A. Bassett, Hendrick Mfg. Co., Carbondale, Pa.
C. C. Bawden, Westinghouse Electric & Mfg. Co., New York City.
Gordon Buchanan, C. G. Buchanan Co., Inc., New York City.
Edward M. Buck, Pit and Quarry, Chicago, Ill.
J. S. Burton, Burton Explosives, Inc., Cleveland, Ohio.
M. S. Cheney, The Thew Shovel Co., Lorain, Ohio.
D. Lee Chesnut, General Electric Co., Trenton, N. J.
D. A. Cheyette, Traylor Engr. and Mfg. Co., New York City.
R. W. Conant, Bucyrus-Erie Co., New York City.
H. M. Cooper, Sauerman Bros., Inc., Chicago, Ill.
Irving K. Cox, Allis-Chalmers Mfg. Co., New York City.
J. B. Crew, Marion Steam Shovel Co., New York City.
B. G. Dann, Hendrick Mfg. Co., New York City.
H. M. Davison, Harnischfeger Sales Corp., Milwaukee, Wis.
Frank Edmondsen, Marion Steam Shovel Co., Albany, N. Y.
W. E. Farrell, Easton Car and Const. Co., Easton, Pa.
T. E. Fisher, Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Geo. W. Flounders, New York City.
M. B. Garber, The Thew Shovel Co., Lorain, O.
Fred A. Gill, Armstrong Mfg. Co., Waterloo, Iowa and Gill Rock Drill Co., Lebanon, Pa.
Thos. F. Henson, Thew Shovel Co., Lorain, O.
Harry E. Hopkins, Pit and Quarry, New York City.
L. D. Hudson, Nordberg Mfg. Co., New York City.
L. D. Hudson, Jr., Nordberg Mfg. Co., New York City.
M. J. Kaiser, Burton Explosives, Inc., Cleveland, O.
George H. Keppel, C. G. Buchanan Co., Inc., New York City.
P. J. Kimball, E. I. duPont de Nemours & Co., Wilmington, Del.
H. F. Lawrence, The W. S. Tyler Co., Cleveland, O.
Frank J. Long, Earle C. Bacon, Inc., New York City.
W. C. MacEwen, Allis-Chalmers Mfg. Co., New York City.
L. E. MacFayden, Taylor Wharton Iron and Steel Co., Easton, Pa.
W. Wesley McKee, Link-Belt Co., Philadelphia, Pa.
W. H. Milroy, Earle C. Bacon, Inc., New Haven, Conn.

J. W. Morrissey, Earle C. Bacon, Inc., New York City.
T. J. Morrissey, Earle C. Bacon, Inc., New York City.
R. M. Murdock, Frog, Switch and Mfg. Co., and Manganese Steel Forge Co., Philadelphia, Pa.
W. S. Nicol, Cross Engineering Co., Carbondale, Pa.
E. H. Paull, Rock Products, Chicago, Ill.
E. L. Pemberton, Frog, Switch and Mfg. Co., and Manganese Steel Forge Co., Philadelphia, Pa.
Wm. H. Quinn, Chain Belt Co., Cleveland, O.
W. Vincent Pietsch, Earle C. Bacon, Inc., New York City.
A. W. Randle, Pit and Quarry, Chicago, Ill.
F. O. Reedy, Kennedy-Van Saun Mfg. & Engr. Co., New York City.
J. H. Robins, Robins Conveying Belt Co., New York City.
Nathan C. Rockwood, Rock Products, Chicago, Ill.
S. R. Russell, E. I. duPont de Nemours & Co., Wilmington, Del.
H. C. Ryder, The Hayward Co., New York City.
R. E. Savage, The Thew Shovel Co., Lorain, O.
Wm. A. Schnell, Link-Belt Co., Chicago, Ill.
R. R. Shafter, Traylor Engr. & Mfg. Co., Allentown, Pa.
Bruce G. Shotton, Hendrick Mfg. Co., Pittsburgh, Pa.
L. W. Shugg, General Electric Co., Schenectady, N. Y.
G. E. Stoltz, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
H. L. Strube, Link-Belt Co., Chicago, Ill.
P. C. Tennant, Texas Co., New York City.
Frank B. Ungar, Ludlow-Saylor Wire Co., St. Louis, Mo.
Franklin P. Waller, Harnischfeger Corp., Milwaukee, Wis.
Ed. Webster, Ross Screen and Feeder Co., New York City.
Norman O. Weil, W. S. Tyler Co., Cleveland, O.
Fred S. Wells, Stephens-Adamson Mfg. Co., New York City.
W. N. Westland, Marion Steam Shovel Co., Marion, O.
E. E. Winship, Loomis Machine Co., Tiffin, O.
Edwin T. Wolf, E. I. duPont de Nemours & Co., Narberth, Pa.

Guests

F. L. Andrews, Mgr., William Penn Hotel, Pittsburgh, Pa.
Wm. M. Andrews, Lake Erie Limestone Co., Youngstown, O.
B. R. Babcock, Callanan Road Improvement Co., South Bethlehem, N. Y.
Wm. F. Barrman, Barrman Stone Products, Inc., Norwood, N. Y.
J. R. Boyd, National Crushed Stone Association, Washington, D. C.
J. R. Callanan, Callanan Road Improvement Co., South Bethlehem, N. Y.
F. O. Earnshaw, Carbon Limestone Co., Youngstown, O.
A. T. Goldbeck, National Crushed Stone Association, Washington, D. C.
O. M. Graves, General Crushed Stone Co., Easton, Pa.
F. T. Gucker, John T. Dyer Quarry Co., Norristown, Pa.
Bernard A. McKinney, West Roxbury Trap Rock Co., Boston, Mass.
A. S. Owens, Eastern Rock Products, Inc., Utica, N. Y.
P. B. Reinhold, Reinhold and Co., Pittsburgh, Pa.
John Rice, General Crushed Stone Co., Easton, Pa.
Geo. E. Schaefer, General Crushed Stone Co., Rochester, N. Y.
F. W. Schmidt, Buffalo Crushed Stone Co., Morristown, N. J.
John H. Schmidt, North Jersey Quarry Co., Morristown, N. J.
W. L. Sporborg, General Crushed Stone Co., Syracuse, N. Y.
A. L. Worthen, The Connecticut Quarries Co., Inc., New Haven, Conn.

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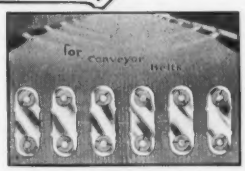

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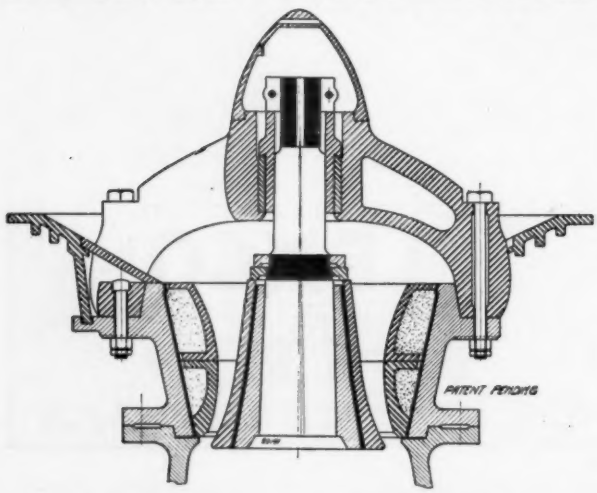

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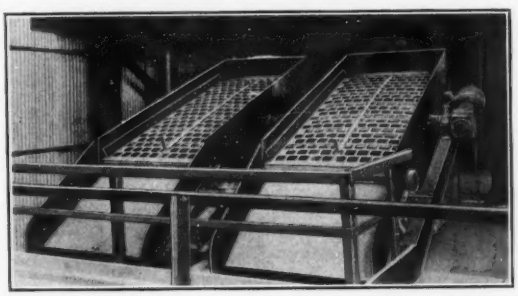

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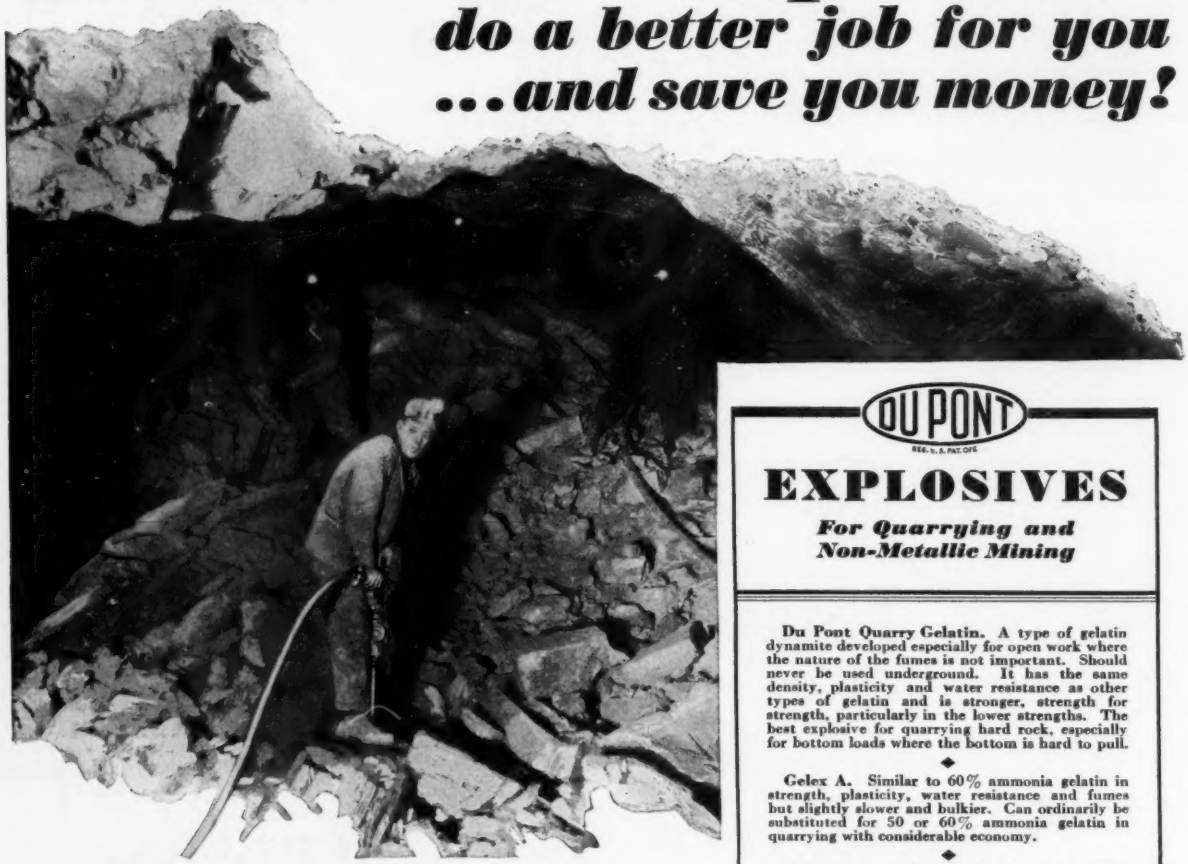

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◆

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